

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

34668-PCT USA

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

09/936932

INTERNATIONAL APPLICATION NO.
PCT/GB00/01029INTERNATIONAL FILING DATE
20 March 2000PRIORITY DATE CLAIMED
19 March 1999

TITLE OF INVENTION

LIQUID DISPENSING APPARATUS

APPLICANT(S) FOR DO/EO/US

HAGERLID, Peter; EHRLING, Hanno; and EKSTROM, Bjorn

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Form PCT/IB/308, a postcard and a check in the amount of \$1,372.

Express Mail No. EF321682170US

Date of Deposit: September 19, 2001

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 09/936932)		INTERNATIONAL APPLICATION NO. PCT/GB00/01029		ATTORNEY'S DOCKET NUMBER 34668-PCT USA	
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24. The following fees are submitted:.				CALCULATIONS PTO USE ONLY																																																																																											
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00 <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00																																																																																															
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<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">CLAIMS</th> <th style="width: 20%;">NUMBER FILED</th> <th style="width: 20%;">NUMBER EXTRA</th> <th style="width: 15%;">RATE</th> <th style="width: 15%;"></th> <th style="width: 15%;"></th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>29 - 20 =</td> <td>9</td> <td>x \$18.00</td> <td></td> <td style="text-align: right;">\$162.00</td> </tr> <tr> <td>Independent claims</td> <td>4 - 3 =</td> <td>1</td> <td>x \$80.00</td> <td></td> <td style="text-align: right;">\$80.00</td> </tr> <tr> <td colspan="4">Multiple Dependent Claims (check if applicable).</td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> <td style="text-align: right;">\$270.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">TOTAL OF ABOVE CALCULATIONS =</td> <td style="text-align: right;">\$1,372.00</td> </tr> <tr> <td colspan="5"> <input type="checkbox"/> Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2. </td> <td style="text-align: right; vertical-align: bottom;">\$0.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">SUBTOTAL =</td> <td style="text-align: right;">\$1,372.00</td> </tr> <tr> <td colspan="4" style="vertical-align: top;"> Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). </td> <td colspan="2" style="text-align: center; vertical-align: bottom;">\$0.00</td> </tr> <tr> <td colspan="5" style="text-align: right;">TOTAL NATIONAL FEE =</td> <td style="text-align: right;">\$1,372.00</td> </tr> <tr> <td colspan="4" style="vertical-align: top;"> Fee for recording the enclosed assignment (37 CFR 1.21(h)). 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A duplicate copy of this sheet is enclosed. </td> </tr> <tr> <td>c.</td> <td> <input checked="" type="checkbox"/> </td> <td> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4377 A duplicate copy of this sheet is enclosed. </td> </tr> <tr> <td>d.</td> <td> <input type="checkbox"/> </td> <td> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. </td> </tr> </table> <p>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p> <p>SEND ALL CORRESPONDENCE TO:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top;"> Janet M. MacLeod, Ph.D. BAKER BOTTS LLP 30 Rockefeller Plaza New York, NY 10112-0228 </td> <td style="width: 50%; vertical-align: top;"> <div style="text-align: center;"> </div> <div style="text-align: center;"> SIGNATURE <hr/> Janet M. MacLeod <hr/> NAME <hr/> 35,263 <hr/> REGISTRATION NUMBER <hr/> 19 September 2001 <hr/> DATE </div> </td> </tr> </table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE			Total claims	29 - 20 =	9	x \$18.00		\$162.00	Independent claims	4 - 3 =	1	x \$80.00		\$80.00	Multiple Dependent Claims (check if applicable).				<input checked="" type="checkbox"/>	\$270.00	TOTAL OF ABOVE CALCULATIONS =					\$1,372.00	<input type="checkbox"/> Applicant claims small entity status. (See 37 CFR 1.27). 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1. A cassette comprising a plurality of cartridges for dispensing drops of liquid in the range 10 - 500 nl therefrom, each cartridge comprising a liquid reservoir and an outlet member mounted so as to close an opening in the liquid reservoir at one end thereof, said outlet member providing an outlet port through which said liquid can be forced by a pulse of pressurised gas applied to the liquid at the other end of the liquid reservoir, thereby forming a said drop.
2. A cassette as claimed in claim 1 wherein at least the liquid reservoirs of said cartridges are formed integrally with one another.
3. A cassette as claimed in claim 1 or 2 wherein said outlet port comprises an aperture in said outlet member.
4. A cassette as claimed in claim 1 or 2 wherein said outlet port comprises a protruding nozzle.
5. A liquid dispensing apparatus comprising a liquid reservoir, an outlet port and driving means for forcing liquid through said outlet port, said driving means comprising means for generating a pulse of gas which impinges upon liquid in the reservoir so as to force liquid through the outlet port.
6. An apparatus as claimed in claim 5, wherein said outlet port is formed integrally with the or each liquid reservoir.
7. An apparatus as claimed in claim 5 wherein said outlet port is provided by a separate outlet member which is mounted so as to close an opening in the liquid reservoir.

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8. An apparatus as claimed in claims 5, 6 or 7 wherein said outlet port and liquid reservoir are moulded from

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Liquid Dispensing Apparatus

This invention relates to liquid dispensing
5 apparatus and in particular to liquid dispensing
apparatus which are able to dispense small volumes of
liquid.

In certain applications it is desirable to be able to dispense very small volumes of liquid from a container, for example in the range 10-500 nanolitres (nl). Drops of this size cannot normally be produced by pumping liquid out of a capillary since surface tension will hold the drop to the tip of the capillary until it is sufficiently large that its weight overcomes this surface tension. This does not happen until the volume of the drop is of the order of 10 to 50 microlitres - i.e. 2 to 3 orders of magnitude greater than the range of interest.

Devices are available which overcome this limitation by forcing a measured amount of liquid through the tip of a nozzle using a piezo-electric actuator acting on the liquid. However such systems are expensive and may only be used with a single type of liquid at a time - thus multiplying the cost where several different liquids need to be dispensed.

It is an object of the present invention to provide an improved apparatus and when viewed from a first aspect the invention provides a liquid dispensing apparatus comprising a liquid reservoir, an outlet port and driving means for forcing liquid through said outlet port, said driving means comprising means for generating a pulse of gas which impinges upon liquid in the reservoir so as to force liquid through the outlet port.

Thus it will be seen that in accordance with the invention liquid may be dispensed by forcing it through the outlet port by means of a pulse of gas. The volume of liquid dispensed may be controlled by adjusting the

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amplitude and duration of the gas pulse. It has been found that this enables accurate control of the volume dispersed, down to the order of 50-500 nl in the preferred embodiment. Furthermore as a gas is used as the medium for transmitting force to the liquid, it is not necessary for any part of the driving means to be in contact with the liquid to be dispensed. This has clear advantages both from the point of view of preventing contamination of the liquid and also the reduced necessity to clean the apparatus.

As the driving impulse is applied to liquid in the reservoir, it is not necessary to have any part of the driving means arranged in the vicinity of the outlet port. This means that the outlet port can be simple to manufacture and the outlet port may even be provided on a disposable member.

In one preferred arrangement in accordance with the invention, the outlet port is an integral part of the apparatus. In a particularly preferred embodiment one or both of the outlet port and the liquid reservoir are moulded from a suitable plastics material, thereby allowing them to be made disposable. More preferably the outlet port and liquid reservoir are both moulded from suitable plastics, most preferably integrally with each other, to form a cartridge. Alternatively such a cartridge could be made from one or more other suitable materials such as silica or stainless steel.

Cartridges of the kind described above may be provided singly, but preferably a plurality are provided in a cassette. Such an arrangement is novel and advantageous in itself and thus when viewed from a second aspect the present invention provides a cassette comprising a plurality of cartridges for dispensing liquid therefrom, each cartridge comprising an outlet port in the form of a protruding nozzle and a liquid reservoir integrally formed therewith.

Preferably the cartridges are formed integrally

with one another to form said cassette.

The invention makes it possible, at least in some preferred embodiments, to provide cartridges pre-filled with the necessary liquid and having the required outlet port formed integrally therewith. All that is necessary then is simply to place the liquid reservoir of the cartridge or each cartridge of a cassette of cartridges in gaseous communication with a means to generate gas pulses, in order to form a liquid dispensing apparatus in accordance with the first aspect of the invention. This is extremely convenient to a user who thus does not need to be concerned with filling reservoirs with liquid, cleaning the outlet port etc. Indeed in at least preferred embodiments of this aspect of the invention, contact with the liquid to be dispensed may be completely avoided.

In other preferred arrangements the outlet port is provided by a separate outlet member which is mounted so as to close an opening in the liquid reservoir. This is advantageous since it allows the liquid reservoir and outlet member to be made from different materials each of which can be optimised for its function. For example, the dimensions of the liquid reservoir may be relatively uncritical and so it could be made relatively inexpensively, e.g. as an injection moulded plastics component. On the other hand, the dimensions of the outlet port of the outlet member are likely to be more critical and it might for example be made to a tighter tolerance, e.g. from metal.

As above, the outlet member and liquid reservoir preferably together form a cartridge, and in preferred embodiments a cassette comprising a plurality of such cartridges is provided. Thus when viewed from a further aspect the present invention provides a cassette comprising a plurality of cartridges for dispensing liquid therefrom, each cartridge comprising a liquid reservoir and an outlet member mounted so as to close an

Preferably at least the liquid reservoirs of said
5 cartridges are formed integrally with one another to
form said cassette.

More preferably, the outlet port comprises an aperture in a wall of the liquid reservoir. The aperture is chosen in size to give the required volume of drop when a given pressure pulse is applied. The aperture however should be small enough that the surface tension in the liquid in the reservoir prevents it from leaking through.

Where, as is preferred, a plurality of cartridges together form a cassette, each may have its own such wall member or two or more of the cartridges may share a wall member with an aperture for each cartridge.

35 The aperture could be any shape, but most conveniently it is round. However, if larger volumes of liquid are required an elongate slit could for example

by employed.

In preferred embodiments the aperture is between 2 and 300 micrometers wide, preferably approximately 40 micrometers. If the aperture is a slit it could for example be 40 x 500 micrometers.

The wall member could be made from any suitable material, e.g. plastics, metal, glass or ceramics. Preferably it has the opposite relationship to water as the liquid for which it is intended to be used, i.e. preferably the member is hydrophilic if the liquid is hydrophobic and vice versa. It may have any suitable thickness, but preferably it is between 10 micrometers and 1000 micrometers (1 mm), most preferably approximately 50 micrometers.

The aperture may be formed by suitably precise technique e.g. etching, electroplating, laser drilling or mechanical drilling.

The wall member may be fixed to the or each liquid reservoir in any suitable manner e.g. gluing, ultrasonic welding, friction welding etc. In one preferred embodiment the liquid reservoir tapers towards its open end and the wall member is pressed into an interference fit with the tapered end. The wall member therefore preferably has the same peripheral shape as the liquid reservoir, most preferably this being round. The diameter of the wall member in such a case is preferably between 0.5 and 6 mm, most preferably approximately 2 mm.

The cartridge or each cartridge of a cassette may be filled with a suitable liquid prior to use, e.g. a lyophilised reagent which is dissolved in water when required. The preferred embodiments of the invention in which the liquid reservoir is adjacent the outlet port are advantageous in this context since just the required amount of reagent can be made up as required without extra being required to accommodate dead space in pipes etc.

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Cassettes of cartridges in accordance with the invention as described above are useful in many applications including but not limited to immuno assays, cell assay, drug screening and they are particularly useful for sequencing DNA using the method often referred to as "Sequencing By Synthesis" as they allow for example a cassette having cartridges containing each of the four nucleotides required for DNA sequencing. Preferably therefore the cartridges respectively contain one or more nucleotides. The ability to provide a plurality of cartridges in a single cassette further allows a complete set of reagents required for a sequencing programme to be provided. Thus preferably further cartridges of the cassette respectively contain one or more enzymes, more preferably selected from a group comprising polymerase, luciferase, adenosine triphosphate (ATP) sulfurylase, and a nucleotide-degrading enzyme such as apyrase. Such a set of reagents is particularly useful for the method of genetic sequencing set out in WO 98/13523. Indeed it will be appreciated that the invention extends to a method of genetic sequencing using a liquid dispensing apparatus or cassette as herein described.

As discussed above, cartridges of the kind described above may be filled by a user with the appropriate liquid as required. Alternatively the cartridge or each cartridge of a cassette is pre-filled with the appropriate liquid and sealed, the seal being broken upon mounting the cartridge into an apparatus which includes the gas pulse generation means. Preferably the seal is broken by the action of mounting the cartridge into the apparatus. Advantageously a conduit for establishing gaseous communication with the interior of the liquid reservoir of the cartridge breaks the seal.

It will be seen from the above that a sealed cartridge containing a liquid to be dispensed by means

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Where an enzyme is provided, either as the predetermined liquid in a pre-filled cartridge or as a separate reagent to be added by a user, the enzyme is preferably selected from a group comprising polymerase, luciferase, adenosine triphosphate (ATP) sulfurylase, and a nucleotide-degrading enzyme such as apyrase.

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The means for generating the gas pulses may comprise any suitable means - e.g. a bellows arranged to undergo a rapid reduction in volume. Preferably however the pulse generation means comprises a source of

5 pressurised gas which may be selectively placed into communication with the liquid reservoir. Such arrangements are especially beneficial since a single source of pressurised gas may be used to drive a plurality of liquid reservoirs, thereby giving a

10 significant saving in cost over arrangements where driving means are individually provided for each of a number of nozzles. Means for selectively placing the liquid reservoir into communication with the source of gas may be provided for each of such liquid reservoirs

15 or two or more of them may be associated with a single selection means so that their contents are dispensed simultaneously.

Preferably one or more valves is provided to effect said selective communication and in the preferred

20 embodiment an electromagnetic valve is used. This is particularly advantageous since electromagnetic valves can be operated very quickly and accurately with little mechanical wear.

Where, as is preferred, the apparatus for

25 dispensing liquid comprises gas pulse generation means in the form of means for selectively communicating a source of pressurised gas with the liquid reservoir, the source of pressurised gas may be comprised within the apparatus. Most preferably the source of pressurised

30 gas comprises a compressor supplying a pressure reservoir. Alternatively, the apparatus may comprise a gas inlet for connection to an external source of pressurised gas. In either case the apparatus of the invention preferably comprises means to regulate the

35 pressure of the incoming gas thereby allowing the amplitude of the pulses generated to be accurately controlled and thus the volume of liquid to be

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accurately controlled as a consequence. The pressure regulation means may comprise a mechanical release valve or the like. Preferably however such means comprises an electronic pressure sensor which is used to monitor the pressure in the reservoir or gas inlet and means for increasing or decreasing said pressure in response to the signal from the pressure sensor to maintain the pressure within a predetermined range.

The gas pulse generation means preferably generates pressure pulses having an amplitude in the range 200 to 1000 millibars, with a pulse width in the range 1-1000 milliseconds. This enables volumes in the range 50 nl to 10000 nl (10 μ l) to be dispensed.

Certain preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a schematic view of a cassette of cartridges and liquid dispensing apparatus in accordance with the invention; and

Figure 2 is a cross-section through a cartridge in accordance with a second embodiment of the invention.

Turning to Figure 1 there may be seen a liquid dispensing apparatus comprising a cartridge cassette designated generally by the reference numeral 1. This cassette contains eight cartridges 2, three of which are visible in the drawing. Each cartridge 2 is partly filled with a reagent 4 used for genetic sequencing. The volume of the cartridges is approximately 2 ml. Different reagents 4 are provided in each cartridge 2. Specifically, four of the cartridges 2 contain the deoxynucleotide triphosphate of one each of the four bases cytosine, guanine, adenosine and thymine. Four further cartridges 2 contain polymerase, luciferase, apyrase and ATP sulfurylase. Equally however some or all of the cartridges could have the same contents.

At the end of each cartridge 2 there is a capillary nozzle 6. This nozzle has a bore of 0.1 mm. In the

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depicted embodiment the nozzle 6 is integrally moulded with the rest of the cartridge 2 from a polymer. However the cartridge could be formed with means to receive a separate nozzle.

5 The cassette 1 has an outer case 8 which protects the cartridges 2 from contamination by the user handling them and conversely protects the user from having to come into contact with the liquid being dispensed or the very fine, i.e. sharp nozzles 6. Apertures 10 are
10 provided in the base of the cassette casing 8 which are aligned with the nozzles 6 to allow the liquid through.

At the upper end of the cassette 1 a thin metal foil 16 is provided over the tops of the cartridges 2 to seal them. The foil 16 extends across the open upper
15 end of the cassette 1 formed by the side walls of the casing 8, but slightly downwardly set from the top edge so as to leave an upstanding lip around the top of the foil 16.

The cassette 1 is installed in a carriage 18 which
20 can be moved laterally in both directions over a Micro Titre Plate (MTP) 12. The MTP has 96 wells 14, three of which are shown. The cassette 1 is actually received in a downwardly tapering chamber 20, so as to rest on an apertured plate 22, the apertures of which are in
25 alignment with the apertures 10 in the cassette and, when the carriage 18 is properly positioned, also with the wells 14 of the MTP 12.

The cassette 1 is retained in the chamber 20 by means of a hinged lid 3, having a rubber seal 24 on its
30 underside which is a tight fit inside the lip at the top edge of cassette casing 8. The seal 24 is arranged also to ensure that the cartridges 2 are sealed with respect to one another as well as with respect to the lid 3.

Mounted in the lid 3 is an array of punching
35 cannulae 28, one for each of the cartridges 2. These cannulae 28 have sharp tips and so as the lid 3 is hinged downwardly onto the cassette 1 in the chamber 20,

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the cannulae 28 pierce the foil seal 28. The other ends of the cannulae are each connected by means of a pipe 26 to an electromagnetic valve (not shown) which selectively connects the pipe 26 to a source of pressurised gas for a predetermined time to produce a pulse of gas. The pressurised gas is generated by a compressor type EC Genius/M 202 2305 EU.SV.C which is commercially available from Fini, Zola, Predosa, Bo - Italy.

10 The pulse of gas forces a measured amount of
reagent 4 out of the cartridge 2, through the nozzle 6
and into the corresponding well 14 on the MTP 12. A
500 millibar pulse, for 10 milliseconds dispenses
approximately 200 nanolitres of reagent into the well
15 14. Reagent is only dispensed from one of the
cartridges 2 at a time although simultaneous dispensing
is also possible and this could be useful e.g. where a
plate having a greater number of wells was used with an
interleaved series of wells used so that dispensing into
20 the wells of several distinct series can be carried out
without moving the carriage 18.

Once the reagents in the cartridges have been used, the cassette may simply be removed by opening the lid 3 and replaced with a new one, the fresh seals being broken by the cannulae 28. Since neither the cannulae 28 nor any other permanent part of the apparatus comes into contact with the reagents at any stage, there is little chance of contamination and it is not necessary to clean the apparatus between uses, even if different reagents are being used.

Figure 2 shows part of the cartridge 30 of another embodiment of the invention. It will be seen that the liquid reservoir 32 tapers at its lower end 32a to form an opening circumscribed by an annular lip 34. The reservoir 32 and lip 34 are integrally formed in injection moulded plastics. The bottom opening is closed by a thin metallic foil disc 36 which has a central

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Although embodiments of the invention having a cassette comprising several cartridges have been described, it will be understood by those skilled in the art that the invention is not limited to using several cartridges and that a single cartridge reservoir could be used instead. Furthermore, the liquid reservoir need not be removable and could instead be an integral part of the apparatus.

Q. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 8

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Claims:

1. A cassette comprising a plurality of cartridges for dispensing liquid therefrom, each cartridge comprising a liquid reservoir and an outlet member mounted so as to close an opening in the liquid reservoir, said outlet member providing an outlet port through which said liquid can be forced by a pulse of pressurised gas.
2. A cassette as claimed in claim 1 wherein at least the liquid reservoirs of said cartridges are formed integrally with one another.
3. A cassette as claimed in claim 1 or 2 wherein said outlet port comprises an aperture in said outlet member.
4. A cassette as claimed in claim 1 or 2 wherein said outlet port comprises a protruding nozzle.
5. A liquid dispensing apparatus comprising a liquid reservoir, an outlet port and driving means for forcing liquid through said outlet port, said driving means comprising means for generating a pulse of gas which impinges upon liquid in the reservoir so as to force liquid through the outlet port.
6. An apparatus as claimed in claim 5, wherein said outlet port is formed integrally with the or each liquid reservoir.
7. An apparatus as claimed in claim 5 wherein said outlet port is provided by a separate outlet member which is mounted so as to close an opening in the liquid reservoir.
8. An apparatus as claimed in claims 5, 6 or 7 wherein said outlet port and liquid reservoir are moulded from

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plastics to form a cartridge.

9. An apparatus as claimed in claim 8 comprising a cassette, said cassette comprising a plurality of said
5 cartridges.

10. An apparatus as claimed in any of claims 5 to 9 wherein the pulse generation means comprises a source of pressurised gas which may be selectively placed into communication with the liquid reservoir.

11. An apparatus as claimed in claim 10 wherein one or more electromagnetic valves is provided to effect said selective communication.

12. An apparatus as claimed in any of claims 5 to 11 wherein said gas pulse generation means is arranged to generate pulses having an amplitude in the range 200 to 1000 millibars.

13. An apparatus as claimed in any of claims 5 to 12 wherein said gas pulse generation means is arranged to generate pulses having a width in the range 1 to 1000 milliseconds.

14. An apparatus as claimed in any of claims 5 to 13 wherein the or each outlet port comprises a protruding nozzle.

30 15. A cassette or apparatus as claimed in any of claims
5 to 13 wherein said outlet port comprises an aperture
in a wall of the liquid reservoir.

16. A cassette or apparatus as claimed in claim 3 or 15
35 wherein said aperture has a width of between 2 and 300
micrometers.

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17. A cassette comprising a plurality of cartridges for dispensing liquid therefrom, each cartridge comprising an outlet port in the form of a protruding nozzle and a liquid reservoir integrally formed with the outlet port.

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18. An apparatus or cassette as claimed in any preceding claim wherein the or each liquid reservoir contains a quantity of liquid and is closed at one end thereof by a frangible sealing means.

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19. A cartridge comprising a liquid reservoir having a predetermined liquid received therein, said reservoir being closed at one end thereof by frangible sealing means, and a nozzle attached to or integrally formed with said reservoir and in fluid communication therewith.

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20. An apparatus, cartridge or cassette as claimed in claim 18 or 19 wherein said frangible sealing means comprises a foil membrane.

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21. An apparatus, cartridge or cassette as claimed in any preceding claim wherein said liquid reservoir contains a nucleotide or enzyme.

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22. An apparatus, cartridge or cassette as claimed in claim 21 wherein said liquid receiving reservoir contains an enzyme selected from a group comprising polymerase, luciferase, adenosine triphosphate (ATP) sulfurylase, and a nucleotide-degrading enzyme such as apyrase.

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23. A liquid dispensing apparatus including a cassette or cartridge as claimed in any of claims 1 to 4 or 15 to

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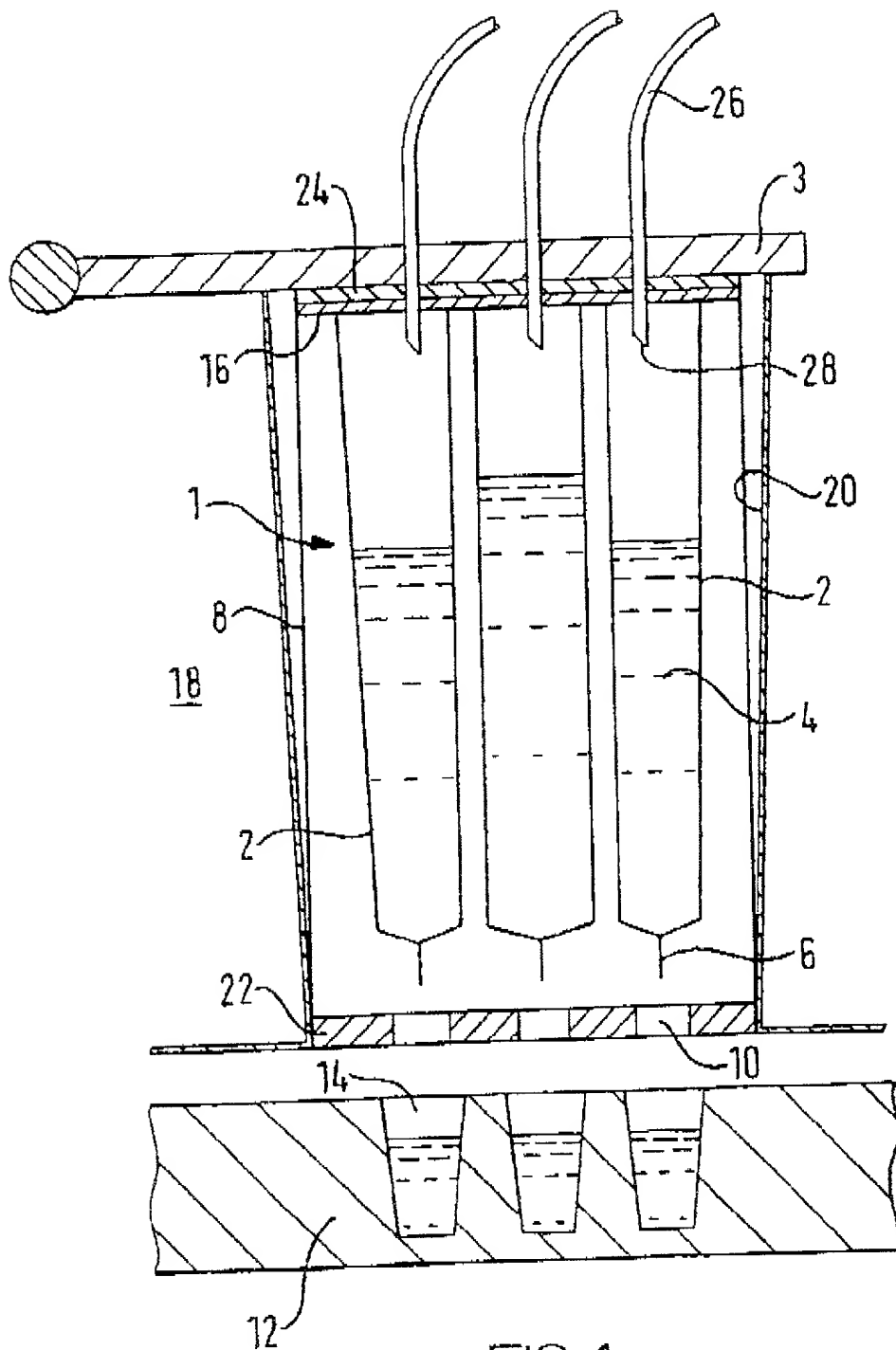


FIG. 1

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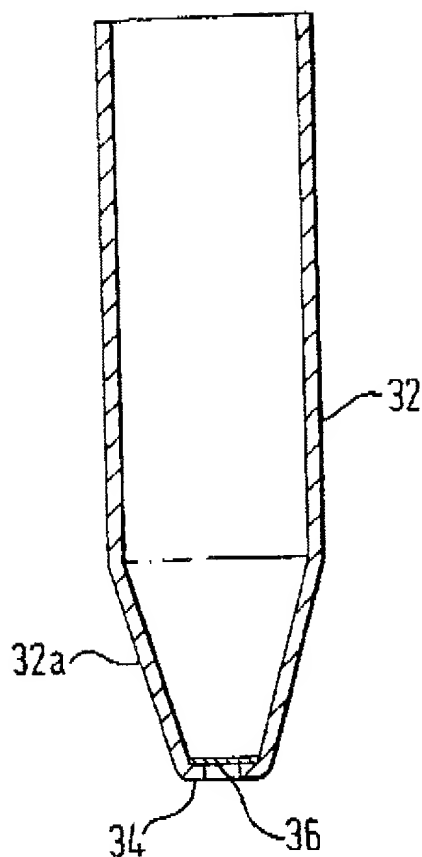


FIG. 2